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Development and application of an Individual Based Model for Longfin Smelt in the San Francisco Estuary

Abstract: Declines in the abundance of Longfin smelt (*Spirinchus thaleichthys*) in the Sacramento Delta and San Francisco Bay (Bay-Delta) have increased the need for casual identification. We developed an individual-based population life-cycle model (IBM) to integrate field and laboratory data into a quantitative measure of the impact of multiple stressors on Longfin smelt population dynamics. Constitutive relationships utilized in the IBM for the egg and larval life-stages included movement and mortality. Eggs were modeled with low probabilities of movement (i.e., Longfin smelt eggs typical adhere to a surface once laid) while larvae were assumed to be passively moving particles with their motions controlled by hydrodynamic forces. The Delta Simulation Model II (DSM2), developed by the California Department of Water Resources, was used as the hydrodynamic model to guide the transport of larvae. Mortality of eggs and larvae were modeled as functions of water temperature. Constitutive relationships utilized in the IBM for the post-larval through the adult life-stages included: movement, growth, mortality, and fecundity. Movement was modeled utilizing a two-dimensional biased Gaussian run and tumble approach, where the bias reflects habitat suitability (i.e., food availability, salinity, water temperature, and depth). Growth was modeled through a bioenergetics approach, life-stage specific mortality was modeled following decay rate expressions, and fecundity was modeled based upon empirical relationships between Longfin smelt size and egg production. We present the results of a baseline simulation and a sensitivity analysis of the Longfin smelt IBM.

Statement of Relevance: The development of a Longfin smelt individual based life-cycle model aims to assess the significance of multiple stressors on the Longfin smelt population dynamics, with regards to the observed decline in the abundance indices of Longfin smelt and in context of the Pelagic Organism Decline (POD).